

ARTHROPODS TAKEN IN PITFALL TRAPS IN THE PINE BARRENS OF NEW JERSEY¹

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ABSTRACT: The diversity, abundance, and seasonal distribution of arthropods taken in barrier pitfall traps in the pine barrens of New Jersey are presented.

The pine barrens of New Jersey is the most extensive wilderness tract along the middle Atlantic seaboard and is one of the world's unique natural areas (McCormick, 1970; Forman, 1979; Boyd, 1991). It consists of some 500 to 560 thousand hectares (1.25 to 1.4 million acres) of generally flat, sandy, acidic, and sterile soils on the Outer Coastal Plain of New Jersey. It is the largest of several similar areas in the northeastern United States.

The pine barrens is almost entirely forested with pines, mainly pitch pine, *Pinus rigida*, numerous species of oaks, *Quercus* spp., and, in low lying swamps and borders of streams, Atlantic white cedar, *Chamaecyparis thyoides*, with inroads of hardwood swamps dominated by swamp or red maple, *Acer rubrum trilobum*, as regrowths following clearcuts of the original stands of cedar. Pitch pines constitute the subclimax forest in both upland and lowland areas, the various species of oaks are found mainly in upland areas, while the Atlantic white cedar is limited to lowland areas. In all habitats, the usual understory vegetation is principally a variety of heaths and heath-like shrubs, with the ground cover consisting mainly of lichens and mosses. Seven of the 18 pitfall traps in this study were located in pine-oak upland areas.

Included within the pine barrens of New Jersey are smaller areas of dwarf or pygmy forests known collectively as the Pine Plains, of which the West, East, and Little Plains are the best known. These are upland areas (100' - 200' cl.) which are located near the Burlington-Ocean County boundary. Together, they total approximately 485 to 800 hectares or 1200 to 1500 acres. The outstanding characteristic of these areas is the low coppice, usually not over four to ten feet, of the mature trees which are almost exclusively a serotinous or closed cone type of pitch pine, together with blackjack oak, *Quercus marilandica*. Again, the understory is a variety of heaths and heath-like shrubs. Another distinguishing feature of the pine plains is the frequency of fires which occur, on average, once every eight or nine years, so that only the most highly fire resistant vegetation is able to survive. Eleven of the 18 pitfalls in this study were located in pine plains areas.

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Both the fauna and flora of the pine barrens have a strong southern affinity. This is probably due to the gradual northward migration of southern forms beginning some 12,000 to 10,000 years ago after the retreat of the last of the glaciers when scientists believe the present pine barrens vegetation began to develop. Smith, 1910, stated that "the insect species on the whole resemble those of more southern states, and Georgian or even Floridian forms are not uncommonly met with".

The pine barrens has long been a favorite collecting area for entomologists. In the late 1800s and early 1900s railroads took New York collectors south to Lakewood, Lakehurst, and other stations down the line, while Philadelphia collectors took shore-bound trains across southern New Jersey and got off to do a day's or weekend's collecting in the vicinity of then rural sites such as Atco and DaCosta. Few places in North America have been as thoroughly collected as the Lakehurst area and many original descriptions have been based on type specimens from the pine barrens, including a number of endemics.

In spite of this, there is a dearth of literature treating the arthropods of the pine barrens. An early study of the insects of the pine barrens by Weiss and West, 1924, was based on March to October collections in a four hectare (ten acre) dry woods and an adjoining 1.6 ha (four acre) open area near Lakehurst. Approximately 85% of all species captured were taken in flight, on the ground, or by sweeping vegetation, and about one half of these were Coleoptera and Hymenoptera. Phytophagous insects were most abundant in both woods (45%) and open area while the percentages of predacious and parasitic insects were nearly the same in both habitats. Saprophagous insects were more common in the woods while more pollenizers were found in the open due to the presence of more flowers.

The chapter on arthropods (Boyd and Marucci, 1979) in Forman's book on the pine barrens is more of a general overview than a report on a specific study. Other references that refer to arthropods in the pine barrens of New Jersey are Boyd, 1973, 1978, 1985; Buffington, 1967; Darlington, 1952; Leng, 1902; Leonard, 1974; McCormick, 1970; and McCormick and Andresen, 1960.

The study reported in this paper was undertaken in the spring and summer of 1986 in an effort to obtain more data on the diversity, abundance, and seasonal distribution of ground-dwelling arthropods in the pine barrens of New Jersey. It appears from the results, however, that more than "ground-dwelling" arthropods were taken in the pitfalls.

MATERIALS AND METHODS

Eighteen barrier pitfall traps were set out at selected sites in Burlington and Ocean Counties, New Jersey (Table 1). Some were widely scattered,

seven as far distant from each other as 19 and 25.5 kilometers (12 and 16 miles), but most (11) were placed in a stretch of about 11 km (seven mi) near the boundary between the two counties. All were within the inner core or preservation area of the pines as defined by the N.J. Pinelands Commission (N.J.P.C., 1980).

Each barrier pitfall trap consisted of five shallow, wide-mouth, peanut-butter type glass jars, each one-third filled with an ethylene-glycol base anti-freeze solution and set in the ground with the top of the jar at ground level. Barriers, usually four in number, of 10 cm high, green plastic lawn edging, were installed and staked in a rough cross formation. Each barrier extended outward from a central jar to a peripheral one so that, typically, there were five glass jars at each trap site. A glass cover was placed above each jar, on stakes, to keep out rain.

All traps were set out on March 28 and 29 and were visited weekly from April 3 through September 30 but with visits only every two weeks in July and again in September. All specimens collected were rinsed and then stored in vials in 70% ethyl alcohol for later determination.

RESULTS AND DISCUSSION

Over the twenty five weeks that collections were made during this survey, more than 78,000 specimens were collected and, later, identified to families and counted (Table 2). Seasonal distribution of the total specimens taken varied considerably. The highest totals were taken during April through June, followed by a considerable drop-off from the end of June through August. Collection totals increased again in September but did not approach the April to June figures.

In terms of sheer numbers, the Collembola (>36,000) far exceeded any other taxon but the figures shown in Table 2 do not tell the complete story. Regularly, from June 19 through August 31, at trap #14 located in the Little Plains (Table 1), there appeared to have been an "explosion" of Collembola during intervals between collections. The Collembola became so thick in the collecting jars during these periods that by collection times all the antifreeze solution in the traps had been absorbed, leaving only a thick, muddy biomass, so thick it wouldn't even pour and had to be shaken out. Hundreds, perhaps thousands, of collembolans were lost in this process.

In descending order, the next most numerous taxa were the Formicidae (>20,000), Diptera (>6500), Araneida (>5100), Coleoptera (>3200), Phalangida (>2500), Orthoptera and Dictyoptera (>2000), and Acari (>1000). Of all the major groups, the Hemiptera and Homoptera were the most poorly represented in the samples with only 250 specimens.

Aside from statistics, a few observations seem in order. In the Phalangida,

it was interesting that nearly one third (31%) of all specimens were collected during September, thus providing at least some support for the common name "harvestmen". As expected, among the Araneida, the Lycosidae, or wolf spiders, were the most numerous.

In the Cicindelidae, *Megacephala (Tetracha) virginica* (L.) and *Cicindela unipunctata* F., both previously considered rare (Boyd, 1985), were again the most common tiger beetles (59 and 44 respectively out of 210) collected in the West Plains portion of the pine plains. Ninety-nine of these were collected in traps 2 through 7 (Table 1) located in the Coyle Field area. Among the Carabidae, by far the most numerous species was the ground beetle, *Pasimachus depressus* (127 of 460). Of these, 88 were also taken from Coyle Field traps 2-7.

The large numbers of Silphidae (108), Staphylinidae (430), and Scarabaeidae (1670) taken in these pitfall traps was surprising. Of the Silphidae, 85 were *Nicrophorus orbicollis* Say. Of the Scarabaeidae, 998 were either *Canthon nigricornis* Say or *C. bispinatus* Robinson (not counted separately). Next most numerous scarabs were *Onthophagus* spp. (168), of which 126 were *O. hecate* Panz. and *Geotrupes* spp. (134), of which 97 were *G. splendidus* (Fab.). The presence of such large numbers of these carrion and dung beetles may be attributed, at least in part, to the numbers of amphibians and mammals that fell into and drowned in the traps and whose carcasses were often floating on the surfaces of the antifreeze solution and thus were exposed to the atmosphere. Chief among these carcasses were Fowler's toad, *Bufo woodhousei fowleri* (34), masked shrew, *Sorex cinereus* (33), pine vole, *Pitymys pinetorum* (9), and white-footed mouse, *Peromyscus leucopus* (8).

Of the 224 Lepidoptera larvae taken, 24 were of the buck moth, *Hemileuca maia* (Drury).

In the Diptera, the large number of calyptrate flies (322), most of which were Calliphoridae (Gelhaus, pers. comm.), may be explained by their natural attraction to the same carcasses that drew so many silphids, staphylinids, and certain scarabaeids.

The taking of such large numbers of Mycetophilidae (3503) and Phoridae (1775) in a series of ground-level pitfall traps was surprising. Vockeroth, 1981, stated that mycetophilids "are most abundant in humid areas, especially moist woodland ... many species congregate in moist, dark places such as ... cavities under tree roots ... many species can be swept from undergrowth in woods". Oldroyd, 1964, referred to phorids as having a liking for "dark, secretive, damp and mouldy places, penetrating far into small orifices, the larvae feeding on organic matter that has begun to dry up and mummify".

These descriptions do not apply well to the open, hot, sunny, sandy, droughty surface conditions of the pine barrens of New Jersey. Neither do they apply well to the habitats where pitfall traps were located which, in the majority of places, were in relatively high, dry sites with a minimum amount of leaf

litter on the ground and little evidence of the presence of fungi.

Thus, the presence of so many mycetophilids and phorids may need further examination for possible explanations. The mycetophilids may have been associated in logs, tree cavities, or other types of wood. Some of the phorids may have been associated with ant and termite nests (Oldroyd, 1964) both of which are abundant in the pines. Phorids in general live in such a diversity of habitats and do so many different things that their presence, along with the mycetophilids, may not be as surprising as first thought. This is the view expressed by Gelhaus (pers. comm.) who points to the high numbers of Collembola (which are known to be associated with damp conditions with decaying materials, i.e. leaf litter), and the number of other litter inhabitants like gryllids and blatellids as evidence that the overall results may be a reasonably accurate sampling of a real litter fauna.

As stated earlier, the original purpose of this project was to develop some data on ground-dwelling arthropods in the pine barrens. However, the presence of such large numbers of Silphidae, Scarabaeidae, Mycetophilidae, Phoridae, and even of so many Staphylinidae and Calliphoridae suggests that many of these insects may have been attracted to the traps by one or more odors and flew to the vicinity of the traps and either landed on the carcasses or crawled over the jar lips to drop into the anti-freeze solutions. As a result, the data with respect to ground-dwelling arthropods may be somewhat compromised because of unknown numbers of possible "fly-ins".

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Table 1. Locations of pitfall traps.

No.	County	Twshp.	Location	Habitat & vegetation
1	Burl.	Tabernacle	.9 mi e Goose Pond, off rt. 532	Gray sand and covered with pine needles & <i>Cladonia</i> . Pitch pine, oaks, Black Huckleberry, Sheep Laurel
2	Burl.	Wood-land	West Plains, Coyle Field, .1 mi e of N.J. Forest Fire Service bldg.	Upland dwarf/pygmy forest. White sand, partially covered w. pine needles & dry oak leaves. Pitch pine, oaks. Mt. Laurel, Black Huckleberry, <i>Hudsonia</i> , Pyxie, <i>Cladonia</i> , deer scats
3	Burl.	Wood-land	West Plains, Coyle Field, .3 mi s Rt. 72 entrance to N.J. F.F.S. bldg.	Upland dwarf/pygmy forest. White sand in pocket at edge of woods. Pitch pine, oaks, Black Huckleberry, <i>Cladonia</i>
4	Burl.	Wood-land	West Plains, Coyle Field, .4 mi se off sand road over to Stevenson Rd.	Upland dwarf/pygmy forest. White sand in pocket at edge of woods. Pitch pine, oaks, Mt. Laurel, Black Huckleberry, <i>Hudsonia</i> , <i>Cladonia</i> , ant hills
5	Burl.	Wood-land	West Plains, Coyle Field, .4 mi se off sand road over to Stevenson Rd., .1 mi w, s of runway	Edge of upland dwarf/pygmy forest & cleared area. White sand. Pitch pine, oaks, Black Huckleberry, <i>Cladonia</i> , <i>Hudsonia</i>
6	Burl.	Wood-land	West Plains, Coyle Field, .4 mi se off sand road over to Stevenson Rd., .1 mi w, n of runway	Edge of upland dwarf/pygmy forest & cleared area. White sand. Pitch pine, oaks, Black Huckleberry, <i>Hudsonia</i> , <i>Cladonia</i> .
7	Burl.	Wood-land	West Plains, Coyle Field, .1 mi n of Rt 72, opp. entrance to N.J.F.F.S. bldg. Moved 4/17 to .1 mi e of N.J.F.F.S. bldg.	Upland dwarf/pygmy forest. White sand covered w. pine needles & dry oak leaves. Pitch pine, oaks, Mt. Laurel, Pyxie, <i>Hudsonia</i> , <i>Cladonia</i>
8	Burl.	Wood-land	West Plains. .7 mi s Rt 72 off Stevenson Rd. then 1.5 mi w on sand road to cul-de-sac	Upland dwarf/pygmy forest at edge of cleared turn around. White sand. Pitch pine, oaks, Mt. Laurel, Black Huckleberry, <i>Hudsonia</i>
9	Ocean	Barne-gat	West Plains. 1.3 ml s rt 72 on sand rd 350' e Stevenson Rd	Burned over upland dwarf/pygmy forest. White sand. Sparse vegetation. Pitch pine, oaks, <i>Hudsonia</i>

Table 1. Locations of pitfall traps (Continued).

No.	County	Twshp.	Location	Habitat & vegetation
10	Ocean	Lacey	Off old Cedar Bridge Fire Tower road. 2.7 mi n Rts 72 & 539, 1.3 mi e of Rt 539	Edge of woods & edge of disturbed, cleared area. Pitch pine, oaks, Black Huckleberry, Teaberry, <i>Cladonia</i> , mosses
11	Ocean	Lacey	Off old Cedar Bridge Fire Tower Road. 2.7 mi n Rts 72 & 539, 1.3 mi e of Rt 539, 625' n of C.B.F.T. rd.	In elbow of abandoned woods trail partially grown over w. mosses & <i>Cladonia</i> . Pitch pine, oaks, Black Huckleberry
12	Burl.	Bass River	East Plains. 2.8 mi s Warren Grove. .9 mi w on gravel rd from Rt 539. 1000' in on white sand trail	Upland dwarf/pygmy forest. White sand. Pitch pine. Black Huckleberry, Bearberry, <i>Hudsonia</i> , Broom Crowberry, almost no oaks
13	Burl.	Bass River	East Plains. 2.8 mi s Warren Grove. .9 mi w on gravel rd from Rt 539. 375' off on side trail	Upland dwarf/pygmy forest. White sand. Pitch pine, few oaks, Black Huckleberry, <i>Hudsonia</i> , <i>Cladonia</i> , Broom Crowberry, deer scats
14	Ocean	Little Egg Harbor	Little Plains, Former Overseas Foreign Aeronautical Communications Ctr. 1.0 mi w Warren Grove, 750' up a sloping white sand trail n of Beaver Dam Rd. opp. Aero. Ctr.	Upland dwarf/pygmy forest. White sand. 90% Pitch pine, 10% oaks, Black Huckleberry, Pyxie, <i>Hudsonia</i> , <i>Cladonia</i>
15	Burl.	Washington	Wharton St. For., adj. Rutgers BI/Cr Research Sta. W side Penn St. For. Rd.	Disturbed area, edge of cult. blueberry field. Mixed white & yellow sand. Pitch pine, oaks, Black Huckleberry, <i>Hudsonia</i> , Greenbrier
16	Burl.	Washington	Wharton St. For., adj. Rutgers BI/Cr Research Sta. E side Penn St. For. Rd.	Loose white gravel/sand in clearing in Pitch pine woods. Few oaks, Black Huckleberry, Sheep laurel, <i>Hudsonia</i> , <i>Cladonia</i>
17	Burl.	Pemberton	Chambers Camp on Buffins Meadows, adj. Whitesbog tract, Lebanon St. For., s side Rt 70	White sand area in Pitch pine woods, few oaks, heavily vegetated with <i>Cladonia</i>
18	Ocean	Manchester	Bedside unused white sand private drive off No. Branch Rd., 1.1	Upland pine woods. White sand. Pitch pines & oaks.

Table 2. Tabulation of collections taken in pitfall traps in the pine barrens of New Jersey, March 17 through September 30, 1986.

Taxon	Total	3/28 ¹ 4/17	4/17 4/30	4/30 5/15	5/15 5/29	5/29 6/12	6/12 6/26	6/26 7/13	7/13 7/31	7/31 8/13	8/13 8/31	8/31 9/15	9/15 9/30
Pseudo-scorpionida	41	1	9	8	9	3	8	1				2	
Phalangida	2,555	262	282	228	119	214	309	134	38	58	122	448	341
Acari (mites)	1,101	52	112	75	123	148	190	32	14	25	252	78	
Araneida													
Thomisidae	172	14	25	16	32	39	28	6	4	4	4		
Salticidae	75		22	13	23	11	4			2			
Lycosidae	801	121	86	69	214	153	93	19	5	2	5	9	25
undetermined	4,055	319	674	487	616	694	718	204	54	47	67	101	74
Isopoda	26	1	4	1	5	4	7	3			1		
Diplopoda	101	30	44	9	8	1	4	4	1				
Chilopoda	104	2	26	8	7	4	5	5	4	7	5	7	24
Collembola	>36,013	9,548	6,335	2,864	2,762	1,467	3,144	1,105	?	2,283	1,790	1,080	3,635
Orthoptera													
Tetrigidae	56	7	11	5	5	7	9	4	1	3	3	1	
Acrididae	80	1	6	5	6	14	11	11	10	3	5	6	2
Tettigoniidae	6	1	4					1					
Gryllacrididae	15							1	1	5	3	2	3
Gryllidae	1,179		1	4	78	109	120	79	96	69	147	227	249
Dyctoptera													
Blattellidae	666	10	4	26	5	13	41	95	111	84	137	80	60
Dermoptera	1							1					
Isoptera	98	1		21	4	42	28						2
Hemiptera													
Miridae	16			1	7	2	5	1					
Reduviidae	9	3			3	1	1	1				1	
Emesidae	10	1	1	2	2	2	1	1				1	
Tingidae	11			2	2	4	5						

Taxon	Total	3/28 ¹ 4/17	4/17 4/30	4/30 5/15	5/15 5/29	5/29 6/12	6/12 6/26	6/26 7/13	7/13 7/31	7/31 8/13	8/13 8/31	8/31 9/15	9/15 9/30
Aradidae	11	1	2		2	3	1					2	
Lygaeidae	5			4		1							
Pyrhocoridae	18			2	3	3	7	1				2	
undetermined	18	2	4	5	2	2	2					1	
Homoptera													
Cercopidae	9			1	3	2	3						
Cicadellidae	4				1	1	2						
Aphidae	2			2									
undetermined	34	1	3	4	9	9	7						1
Neuroptera													
Myrmelionidae (larvae)	105		2	11	23	30	16	4	1	2	5	6	5
Coleoptera													
Cicindelidae	210	15	23	8	2	5	8	16	58	41	21	9	4
Carabidae	460	16	21	21	45	30	65	85	47	27	54	33	16
Scydmaenidae	16		1	4		3	6			1	1		
Silphidae	108					1	3	6	8	1	3	60	26
Leptoderidae	13	2	1	1	1	3	3	1		1			
Staphylinidae	440	12	59	40	34	44	37	5	10	15	32	89	63
Pselaphidae	48		3	11	11	9	7	2	3		2		
Lucanidae	1										1		
Scarabaeidae	1,670	13	18	32	71	111	245	345	159	89	141	308	138
Elateridae	25	1	8	3	2	2	5	1	2				1
Lampyridae & Cantharidae	6				4	1		1					
Dermestidae	6						1	1	1	1	1	1	
Bostrichidae, Anobiidae, Cleridae & Lycidae	8			3		3	2						
Nitidulidae	25		2	4	4	7	4	1	2	1			
Cucujidae, Erotylidae & Coccinellidae	10			1	3	1	2	2		1			

Taxon	Total	3/28 ¹ 4/17	4/17 4/30	4/30 5/15	5/15 5/29	5/29 6/12	6/12 6/26	6/26 7/13	7/13 7/31	7/31 8/13	8/13 8/31	8/31 9/15	9/15 9/30
Tenebrionidae	23			7	4	6	4	2	2				
Alleculidae, Mordellidae & Anthicidae	11				2	2	5		2				
Cerambycidae	6							1	2	1			
Chrysomelidae	11		1	1		3	4	2	2				
Scolytidae	27			3	14	6	4						
Cuculionidae	101	15	33	20	5	7	5	2	2	1	1	5	5
Mecoptera	4												
Lepidoptera (larvae)	224	8	23	16	35	34	41	12	5	12	9	21	8
Diptera													
Trichoceridae	85	62	23										
Tipulidae	3		2				1						
Psychodidae	2	1	1										
Culicidae	1											1	
Chironomidae	46	21	19		5	1							
Anisopodidae	3	3											
Mycetophilidae	>3,505	44	23	>2,000	>1,000	264	65		8		2	11	88
Sciariidae	191	43	81		3		1	37	1		7	17	1
Cecidomyiidae	14		4		3	1	2	2			1	1	
Tabanidae	2					2							
Rhagtonidae	1				1								
Therevidae	5		2				2			1			
Asilidae	6					1	2	1	1	1			
Bombyliidae	1				1								
Empididae	28	3		8	10	1	1	1			4		
Dolichopodidae	137			7	30	67	28			2		3	
Lonchopteridae	1		1										
Phoridae	1,775	37	62	29	44	42	32	107		176	205	1,011	30
Pipunculidae	3			1	1	1							

Taxon	Total	3/28 ¹ 4/17	4/17 4/30	4/30 5/15	5/15 5/29	5/29 6/12	6/12 6/26	6/26 7/13	7/13 7/31	7/31 8/13	8/13 8/31	8/31 9/15	9/15 9/30
Acalyptratae	158	8	6	6	14	38	45	6			4	14	17
Sphaeroceridae	158	2	14	2	4	3	10	19		3	31	63	7
Drosophilidae	53							9		2	2	32	8
Calypttratae	322	32	50	6	8	13	49	24	11	20	23	36	50
Siphonaptera	11	2		1			2	2		1		3	
Hymenoptera ²													
Ichneuminoidea	3												
Chalcidoidea	71												
Cynipoidea	21												
Evanioidea	4												
Proctotrupoidea	8												
Tiphidae	6												
Solidae	10												
Mutellidae	26												
Formicidae	>20,303	3,122	1,602	2,991	2,888	3,534	3,845	800	?	425	278	673	145
Pompilidae	23												
Vespidae	29												
Sphecidae	70												
Colletidae	4												
Andrenidae	12												
Halictidae	6												
Megachilidae	1												
Anthophoridae	54												
Apidae	1												
	78,013	13,840	9,740	9,099	8,324	7,224	9,306	3,202	652 ³	3,405	3,143	4,620	5,109

¹ Three week period² Weekly collection records maintained only for Formicidae³ Neither Collembola nor Formicidae included in total

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